Coastal Ecosystems Response to Climate Change and Human Impact in the Asia-Pacific Region (CERCCHI Project)

Part I

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INTRODUCTION

• The **natural and human elements of coastal zones** in the East Asia and the Pacific are **extremely vulnerable** to disturbances associated with natural climate variability together with anthropogenic forcing.

• Increase in **environmental loads** from **adjacent watersheds** such as nutrients and sediments are of particular concern due to their deleterious effects on coastal habitats - mangroves, seagrasses and coral reefs *(see Table 1)*

• Coastal zones contain **complex interactions** between **social, economic and environmental systems** *(see Figure 1 & 2)*.

Coastal ecosystems are severely damaged:

- over 80% of the reefs are at great risk;
- mangroves have lost 70% of their cover in the last 70 years;
- seagrass bed loss ranges from 20-60% in the last 50 years

• **Management** of coastal resources requires consideration of these complex interactions.

• Present investigative efforts are narrow, lacking or produce results that are incompatible to enable understanding of **interrelationships** across systems.

• There is a need to **link science and decision-making** stressing the continuum of expertise from basic science to applied science to **policy, governance** and management.

Location	Agent	Response
Japan	Eutrophication and sedimentation	Declining coral cover
		Change in coral community composition
	Gradients away from rivers	away from source
Philippines	Excess sedimentation from logging	Declining coral cover, declining biodiversity due to disappearance of sediment species, inhibition of coral settlement
Indonesia	Excess nutrients and sedimentation	Low coral cover, reduced coral diversity, unaltered vertical extension but low skeletal density in massive corals, increased bioerosion

TABLE 1: Some of the more comprehensively documented field assessments on the effects of terrestrial runoff, and other forms of pollution, on the ecology of coral reels *(Source: Fabricius (2004), Marine Pollution Bulletin)*

Over-fishing threatens 64% of the reefs, **destructive fishing**, 56%, **coastal development**, 25% & **agriculture & deforestation**, 20%

Human-induced global environmental changes

- Between 1/3 & 1/2 of land surface transformed by human action (Vitousek et al. 1986);
- CO_2 in atmosphere increased by nearly 30% since the Industrial Revolution (Schimel et al. 1995);
- More atmospheric N is fixed by man than by all natural terrestrial sources combined (Vitousek et al. 1997);
- About 2/3 of major marine fisheries fully exploited, overexploited, or depleted (FAO, 1994).

Impacts of these changes

- Disruptions to the global climate (IPCC 1996)
- Depletion of stratospheric ozone (Rowland, 1989; Solomon, 1990);
- Irreversible losses of biological diversity (Lawton & May 1995; Pimm, et al., 1995); &
- Changes in the structure & functioning of ecosystems (Chapin III et al., 1997; Schulze & Mooney 1994).

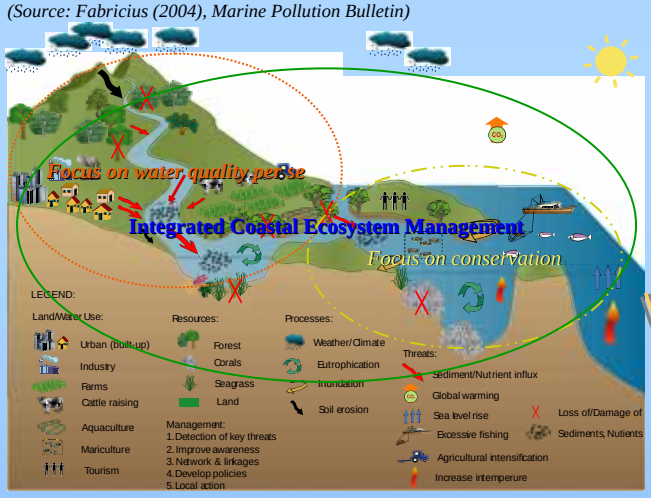

FIGURE 1: A conceptual diagram of the coastal ecosystem: processes and interactions

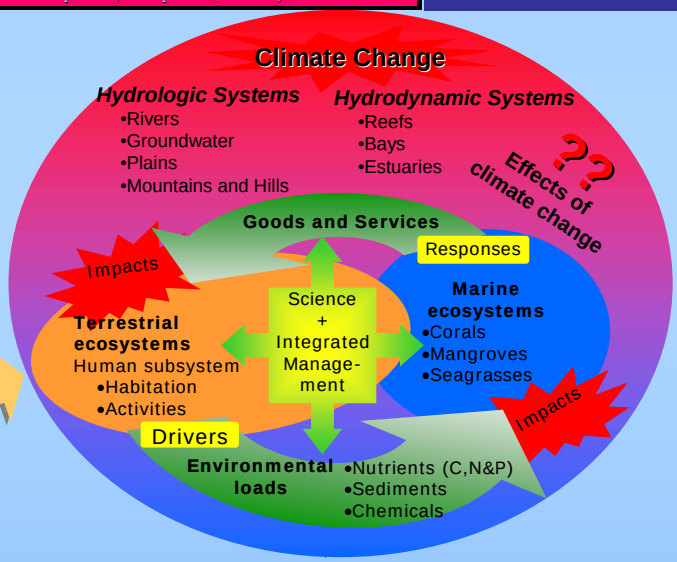

FIGURE 2: Concept of linkages among tropical ecosystems in a changing coastal environment: in terms of drivers, impacts and responses and role of science and local management.

SCOPE of the PROJECT

The project will cover key **spatial** and **temporal aspects** of **change in natural and human systems** in the tropical zone. Viewing these systems as coevolving systems coupled by physical processes (e.g. river hydrology and hydrodynamics) responsible for dynamic interaction and feedback of system elements, the Project will include **measurement of dynamic parameters** such as *carbon, phosphorus and nitrogen (CNP) fluxes, water temperature, salinity, rainfall, sedimentation, tide level and wave action, sediment chemistry, degree, quality and frequency of freshwater flow.*

Application of **remote sensing** data analysis techniques will be a major component of the project to provide a rapid, comparable, and readily available source of spatial records in the Pacific and East Asian region at a larger and broader time scales.

OBJECTIVES of the PROJECT

Produce an accurate set of multi-date coastal resource information particular to needs of managing changes in the coastal zone and consistent to allow comparison among systems in the region.

Provide an understanding of the driving/forcing effects of socio-economically-induced changes on environmental loads to the tropical coastal ecosystems

Assess human welfare impacts of changes in coastal resource systems in terms of social costs and benefits considering different management strategies

Achieve and apply understanding of the causes and consequences of present and future environmental change of tropical ecosystems in management decisions

Develop capacity building through workshops on standardized methods of processing in-situ, remotely-sensed data and environment-related socio-economic surveys

Strengthen the network of, and reinforce linkages among coastal scientists and managers thru shared expertise and resources

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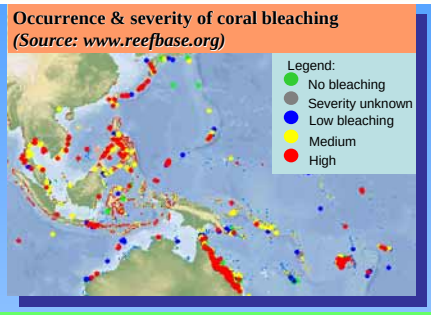
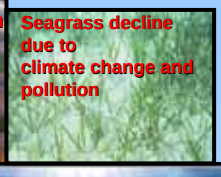
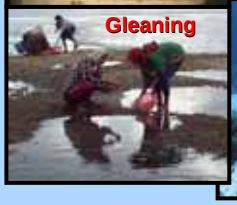
THREATS to COASTAL ECOSYSTEMS



Coral bleaching is the whitening of coral colonies due to the loss of symbiotic zooxanthellae from the tissues of polyps. This loss exposes the white calcium carbonate skeletons of the coral colony

There is a growing body of evidence linking severe coral bleaching and mortality to **increasing rates of global climate change** attributed to rising levels of anthropogenic greenhouse emissions (Goldberg and Wilkinson, 2004).





'Predator plagues like **crown-of-thorns starfish (COTS)** are increasingly reported around areas of human activities with 2 strong hypotheses advanced: the plagues may be initiated and certainly exacerbated by either **over-fishing of key starfish predators**; and/or **increases in nutrient runoff** from the land favors the planktonic stages of the starfish.' (Goldberg and Wilkinson, 2004)

'**Seagrass ecosystems** will respond to the rise in atmospheric CO2 and to the concomitant **climate changes** associated with global warming, higher frequency of storms and increasing sea level. However, the directions of these responses, positive or negative, are less obvious than those of more direct human disturbances, such as eutrophication and siltation.' (Borum)

The PROJECT APPROACH

Assistance for policy formulation

Logistical support

Stakeholders

Government (national and local)
Non-governmental organizations (NGOs)
Community-based organizations

Provision of models, training, technical assistance

Needs identification
Assistance in monitoring work

Data and Information Sharing

Remote Sensing
Geographic Information Systems
Integrated Simulation Modelling
Field techniques

The Project

Multidisciplinary collaboration

Integrated watershed-coastal ecosystem approach

Data collection

Implementation of global/regional monitoring programs

Extraction of products

Policy formulations, coordination and implementation of programs

Data Collection

Improved protection through monitoring and impact assessment

Coastal Ecosystem

PROJECT IMPLEMENTATION

Capacity-building through joint workshops and provision of user-friendly decision support tools suited for local management

Development of a policy-relevant prognostic model equipped with environmental quality indicators and optimization technique to valuate resources and social priorities

Assessment of and relating changes detected in human and natural ecosystems considering hydrologic and hydrodynamic processes by use of physical and ecological models

Analysis of multi-temporal satellite images (e.g. covering a period of 20 years behind) to detect changes in land use patterns and coastal habitats within the region.

Collection and assessment of existing studies and relevant data on changes in the coastal and human impacts in tropical marine ecosystems to identify information gaps

Data and information sharing and dissemination preferably through a website acting as a communication portal for data, information and knowledge base exchange among collaborators and the public.

Fundamentals of the Project Appoach

Basis for the Use of Remote Sensing in the Project

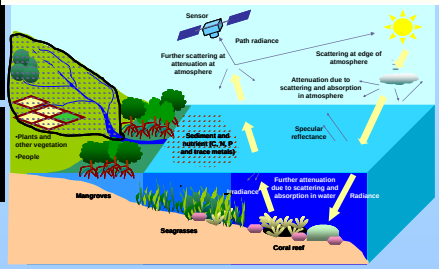


FIGURE 3: Remote sensing research related to coastal habitat monitoring

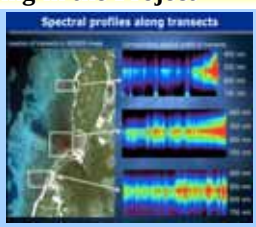


FIGURE 4: Development of seagrass assessment and monitoring methodology using remote sensing

EXPECTED OUTCOMES & OUTPUTS

a. **Impacts of changes to coastal ecosystems** in East Asia and the Pacific region as depicted in **processed multi-temporal images**
b. **Standardized** *in-situ* **data collection protocol**, **uniform methods** for processing remotely-sensed data and socio-economic surveys
c. An **integrated physical and ecological model** specific to assessment of environmental changes in tropical ecosystems
d. A science-based, user-driven practical **decision support system (DSS)** suited for management concerns in coastal zone.
e. A group of **coastal scientists** in the region proficient in environmental change evaluation methods
f. **Managers trained** in using **DSS** for tropical coastal environment.
g. **Documentation** and other **relevant publications** for promoting provisional and actual use of the integrated model

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